

THE SURGICAL ASPECTS OF ANURIA.¹

BY CHARLES GREENE CUMSTON, M.D.,

OF BOSTON, MASS.

By the word anuria is understood that condition in which no urine is formed in the kidney; in other words, there is a complete absence of the secretion. Anuria following abdominal operations occasionally arises, but does not last more than forty-eight hours, although one case has been recorded in which there was suppression of the urinary secretion for twenty-five days, although the subject appeared to be perfectly well during this time. The urine then began to come away and gradually attained the normal amount. There are other cases, however, where anuria of several days' duration sets up phenomena met with in uræmia, and it is quite true that in certain pathologic conditions resulting in the development of deleterious substances in the blood, the patient may be in a very serious condition. These substances are the urinary toxins, combined with the biliary constituents and CO². Understood in the strictest sense, anuria only occurs in functional disturbances of the kidney, or in the various renal affections, but in a broader sense one can include under this name all those abnormal conditions in which the urine is prevented from reaching the bladder. Thus, we have obstruction arising in the ureter or renal pelvis, giving rise to suppression and which may be classified among cases of anuria. True anuria arises when the arterial blood no longer reaches the renal gland, or the escape of the urine secreted in the glomerulæ is prevented by some obstacle met with along the genito-urinary tract.

I would like here to outline a classification of conditions giving rise to various forms of anuria, with the hope that the

¹ Read at the annual meeting of the American Urological Association, at Boston, June 13-14, 1906.

subject may be made as simple as possible. I will first consider those cases resulting from a reflex action, and here one is dealing with anuria produced by some irritation in another organ, and by way of the nerves, the reflex action is carried to the kidney, resulting in suppression of secretion. In this class belongs anuria of hysteria and toxic anuria arising from the intestinal canal. There are also instances of suppression of the urine resulting from an irritation arising in one kidney which, by what is probably a reflex action, prevents the secretion of urine in the healthy organ as well. According to Cohnheim, the anuria of pregnancy should also be considered as of reflex nature and may be traced back to contraction of the renal arteries, but, however, I believe that in these cases an inflammatory process is really at the bottom. As an intermediary or transitional class we should include those cases of anuria which result from an obstruction at some part of the urinary canal, as occurs in certain infectious processes. Here, in all probability, the circulation becomes arrested in the kidney, usually as a result of cardiac weakness, or on account of an increased density of the blood, but the urinary canals of the kidney are usually filled with small plugs of casts, being in reality an obstructive process. The second group includes the anuria met with in nephritis, renal calculi, and in torsion or compression of the ureter, and these cases represent instances of obstruction in the urinary canals. We will now consider the first group, namely *reflex anuria*.

Hysterical Anuria.—It is well-known that the secretion of urine is directly under the control of the nervous system by means of the vaso-motor system. By irritation of the vascular centre in the medulla oblongata one can directly influence the amount of urine secreted by the renal parenchyma. Stimulation by electrical currents, or by inducing an accumulation of CO.² in the blood, one may succeed, if the irritant is of sufficient strength to completely stop the secretion of urine. The point, however, which has by far the greatest importance for the understanding of the production of hysterical anuria,

is the resulting complete anuria by reflex which arises during irritation of a sensory nerve. In their experiments Cohnheim and Rog by stimulation of the central end of a cut sciatic nerve, successfully produced an extreme contraction of the renal vessels with a diminution in the size of the gland. It is very important to note, as these authorities have shown, that the effect of the irritation was present considerably longer than the duration of the stimulation. These experimental demonstrations form the foundation of the hypothesis of reflex anuria in the human subject. The question now arises as to how far clinical experiments correspond to those undertaken on animals and whether or not it can be demonstrated as a certainty that cases of purely nervous anuria can be met with, when the renal glands are absolutely normal. I feel that this may be answered in the affirmative, and here cases of hysterical anuria belong. This form usually arises in neurotic individuals, or in diseases or anomalies in the female genital apparatus. The splanchnic nerve becomes irritated and from this arises a cramp-like contraction of the renal arteries, while the flow of blood to the kidney completely ceases. Hysteria, which represents a perverted reaction of the nervous system, may give rise to changes in the urine due entirely to nervous influence. The polyuria which frequently follows attacks of the affection is well known and, although less frequent, oliguria may also occur and be so marked that anuria is reached. Pitres says, in his clinical lectures on anuria, that the patients succumb from uræmia after a certain time, which may vary from several hours to five or six days on an average, but in hysterical subjects, on the contrary, the anuria may persist for weeks without having any apparent effect on the general health and without causing any danger to life.

If one carefully studies the literature of the subject, it will at once become evident that hysterical patients never give evidence of symptoms of uræmia, *if vomiting and diarrhœa be excluded*. This has induced several authorities to assume that there exists a vicarious secretion of urea by way of the

stomach, and Charcot and others observed that in absolute anuria vicarious vomiting arose, the vomitus containing a relatively large amount of urea. The quantity of urea in the vomitus increased when the urinary secretion was suppressed, and, consequently, it becomes evident that the stomach possesses power to eliminate a certain portion of the urea accumulated in the blood in cases of anuria. The number of such cases, however, is small and there are probably other ways in which the urea becomes eliminated. That a vicarious secretion of urea may take place in the organism there is no doubt, as the experiments of Claude Bernard and Barreswil show. After removal of the kidneys they demonstrated the presence of urea in the blood, and after profuse vomiting had occurred it could no longer be discovered. This phenomena may be explained by the secretion of urea into the intestine and which is also removed partly by vomiting and partly by transformation into carbonic acid ammonia. Hammond and Marchand, as well as Oppler, found the presence of urea in the vomitus in their experiments.

One must be extremely careful in making a diagnosis of anuria when one suspects it to be due to hysteria. For instance, in one case, a girl twenty-four years of age occasionally presented an oliguria and once apparent absolute anuria lasting for two weeks and accompanied with violent vomiting. The patient was carefully watched and it was soon discovered that she carried a small pitcher with her which she kept wrapped up in a handkerchief. This pitcher had a very strong odor of urine. When she was unobserved, she would pour small quantities of urine out of the window, and it was also found that she drank some of it and then vomited.

We now come to the consideration of those cases where the anuria is proven to be purely nervous in origin and the kidneys perfectly healthy, and here again I would refer to Charcot, who published a very well-observed instance. The patient presented evidence of severe hysteria; there were convulsions, hemiplegia and hemianæsthesia with an oliguria,

which had been presented for several months, with periods of absolute anuria which lasted 11 days. During the whole time small amounts of urea were detected in the vomitus. After a deep chloroform narcosis, given for the purpose of breaking up adhesions giving rise to contracted joints, the urine secreted was found normal. This case shows that the long duration of an anuria proves nothing as far as its purely nervous nature is concerned, and this case just quoted was in all probability an angiospastic anuria and, besides, other proofs derived from animal experiments well demonstrate the curative action of the relaxing influence of chloroform narcosis over the vascular spasm. If, then, a nervous anuria really exists, it is probable that it is quite similar to the experimental reflex variety and results from sensory irritation, and this theory appears more or less probable from the two following reported cases. Israel had a 24-year-old woman under his care presenting a stenosis of the external os, uterine catarrh, and constant uterine pain which was increased at each menstruation. For six months oliguria had been present, accompanied by profuse vomiting and occasional anuria. After bilateral incision of the cervix the menstruation following was painless and the oliguria and anuria disappeared. A similar condition was found in a case reported by McBride and Mann, of a woman having intestinal irritation, uterine hypertrophy and a deep bilateral laceration of the cervix, and who usually presented an anuria of many hours' duration during menstruation. Injections of morphine did away with the anuria each time they were given, while an operation for the repair of the cervix also did away with it for some time.

Toxic anuria as it occurs occasionally in chronic lead-poisoning can also be traced to a reflex contraction of the renal blood-vessels, especially the arteries, but, under these circumstances, oliguria is more frequently present than anuria. The same may be said of oxalic acid and cantharides poisoning.

We now come to the question of reflex anuria arising in an occlusion of one ureter, which may be considered as of reflex

nature from the genital tract, and it is of importance to ascertain if sensory irritation affecting one kidney or one ureter is capable of suppressing urinary secretion by reflex action. This may be answered affirmatively, and the fact was already known as far back as Morgagni that in obstruction of one ureter the opposite kidney might sometimes suspend its functions, so that this great pathologist was led to say: "*Nam etsi non semper, haud rarissime tamen contingit, ut uno affecto rene alter quoque in consensum trahatur.*"

Clinically, this form of reflex anuria has been repeatedly met with, and as far as the correctness of the explanation is concerned, namely that, under certain conditions, an inhibitory influence upon the secretion of one kidney on the other can occur, it has been proven by physiological experiments. It was long ago demonstrated by Claude Bernard that, by irritation of the nerves entering the hilum of the kidney, anemia and anuria could be produced, while in contradiction to this, Cohnheim and Roy showed that by irritating the renal nerves a marked hyperæmic tumefaction of the organ, with increased urinary secretion, resulted.

It is only recently, however, that investigations have demonstrated the paths over which the vaso-motor nerve fibres run, and this is of extreme interest from our point of view. Masius, by making a section of the vagus in the neck of rabbits and dogs, whether on the right or on the left side, could by irritation of the peripheral end produce suppression of urine in both kidneys. This phenomenon also took place when the sympathetic was cut in the neck after section of the vagi and the cervical medulla and the central end irritated. From this there resulted a depression in the vaso-constrictor nerve-fibres of the kidney, partly in the splanchnic, partly in the cervical vagi, and on account of this dividing course of the vaso-constrictors in the cervical vagi also, it immediately becomes obvious that, in a perfectly simple and clear manner, one may explain the changes observed in the cardiac action as well as the existing anuria. This has also been proven clinically. For many

English surgeons, however, the reality of reflex anuria resulting from functional obstruction of one kidney does not appear at all likely, and they only believe it possible when some serious lesion is present in the second kidney. Legueu rejects the possibility of a reflex action when a renal lesion exists on one side only, or when a calculus becomes lodged in a ureter, and he asserts that, in calculus anuria from obstruction of one ureter the kidney on the other side, if it fails to carry out its functions, does so because it is, or has been, the seat of some lesion. Demons and Pousson admit that anuria arising in cases of obstruction from stone in one ureter may occur, but it must be extremely rare and presumably a diseased kidney also exists, because it is only under these circumstances that the renal function could be interfered with in a reflex way.

Israel also comes to the conclusion that reflex anuria due to a one-sided obstruction of the ureter usually only takes place when the opposite kidney is already the seat of disease. The reflex interference of the renal function takes place, according to Guyon, from an insufficient blood-supply, due to irritation of the vaso-constrictors, and since he upholds that a diseased kidney requires a greater amount of blood than a healthy one, they naturally suffer more markedly under a reflex irritation than when normal.

Animal experiments carried out by Gotze would appear, however, to be in favor of some reflex influence being brought to bear on the healthy kidney which may impair the latter's functions in cases of obstruction of one ureter by a calculus. In dogs which have passed normal urine the capacity of each kidney was determined quantitatively by inserting a glass tube into each ureter. Salt solution was then injected into one ureter which increased the pressure of the respective kidney and immediately resulted in a decrease in the secretions of the kidney on the opposite side, and when the pressure was kept up resulted in complete suppression of urinary secretion. The same result was obtained when artificial obstruction of one ureter was produced. Increase of intrarenal pressure of one

kidney consequently resulted in arresting the secretion in the opposite gland. From this it would appear that those who have criticised the theory of reflex suppression of urinary secretion have certainly the merit of having disproven a large number of cases which have been reported as reflex anuria, but, nevertheless, the reflex process which arises in connection with renal operations must still be more generally considered than it has in the past. This relates chiefly to the immediate results on the functions of the remaining kidney after nephrectomy. The physiological process after this operation is much more clearly understood than formerly, since surgeons have done away with the injurious influence of antiseptics on the remaining kidney by employing an aseptic technique, and in looking back we can see that in many cases where anuria occurred immediately after the removal of a kidney, it was frequently due to the absorption of toxic products employed for sterilization. It becomes evident at the present time, when functional disturbances occur in the remaining kidney after nephrectomy, that in the majority of cases the process is purely a physiological one, due to a reflex condition acting on the innervation of the renal vessels.

In cases of obstruction of one ureter other than from calculus, the easiest and clearest reason for the occurrence of a reflex suppression of secretion, giving rise to a so-called sympathetic anuria, is met with when acute suppression arises in movable kidney. In these cases, at the time of the attack, a decrease in the amount of urine, or even absolute anuria may occur. When the crisis is over the renal function is restored, so that any supposition of any arrest of the secreting functions having preëxisted in the other kidney must be rejected. Israel has reported a case where this fact cannot be denied, in which he observed a distinct reflex inhibitory influence over the left kidney arising after an acute increase in tension, resulting from a temporary closure of the ureter in a right-sided hydro-nephrosis.

The kidney was enormously distended from time to time

and extremely painful from the tension and, at the time of the attacks, the amount of urine secreted diminished to practically nothing, but as soon as the sac was emptied by puncture a flood of urine was voided by the bladder. This polyuria occurred from the healthy kidney, for the urine voided by the bladder was perfectly normal, whereas that obtained from the hydronephrosis was tinged with blood. In another case Israel was dealing with an increase in intrarenal pressure in one kidney, resulting from bending of an abnormally long ureter, and a suppression of the secretion in the healthy kidney resulted. The occlusion of a left-sided hydronephrosis resulted in a total anuria. The right kidney was incised and during the operation the renal vein was ruptured, death resulting 28 hours after the operation. Microscopic examination showed that the structure of the right kidney was perfectly normal.

According to these observations it becomes evident how an irritation arising in one kidney can suppress the secreting functions in the opposite organ and by removal of the exciting cause the normal kidney will again regain its physiological functions. A still more evident proof, possessing the positiveness of a physiological experiment, is the occurrence of a renorenal reflex resulting in oliguria or anuria when the latter condition is overcome after removal of the diseased kidney during the occurrence of occlusion to the exit of the urine from that side. Here again Israel has reported an interesting case. He removed a diseased kidney, and after the operation the amount of urine voided in 24 hours amounted to three times the quantity expelled before the operation. Here one is dealing with instances of bending of the ureter and hydronephrosis resulting in an increased intrarenal pressure, which by reflex action stopped the excretory function in the opposite gland.

Considering those cases of obstruction due to impaction of a calculus in the ureter on one side and where anuria results, it is difficult to prove the sympathetic nature of the condition. It may be upheld that one ureter is occluded by a calculus,

while the ureter of its fellow may be bent, or the opposite kidney may be diseased and incapable of carrying on its function, or that it may be a rudimentary organ, so that the occluded kidney was in reality the only one carrying out urinary secretion. It is quite true that such conditions have been frequently observed and reported as instances of reflex anuria, but, nevertheless, there are enough authentic recorded cases to be found in which an occlusion by a calculus in one ureter has distinctly resulted in a reflex action arresting the functions in the opposite healthy kidney. Legueu is very positive in asserting that there is no such thing as reflex anuria, and when suppression of the urine does occur, it is due to the fact that the patient possesses only one kidney. Personally, I believe that this opinion is too absolute, and a case recorded by Israel seems to show that the proposition is untenable in every case. After exposing the left kidney and removing a stone from the hilum in a patient 62 years old, Israel noted that the urinary secretion returned immediately and very profusely, both by way of the bladder and through the drainage-tube in the left kidney. By the cystoscope it was found that the right kidney, which had not been operated on secreted normally again, which would seem to prove the reflex nature of the cessation of its function. Legueu, nevertheless, upholds that a reflex calculous anuria cannot exist, and when there is anuria from calculous obstruction, both kidneys must be diseased or only one gland is present. The above-mentioned case, reported by Israel, would seem, however, to prove the contrary, because complete anuria was present with obstruction in one ureter only, which was completely relieved after operation and proved by the cystoscope that urine came into the bladder from the healthy kidney after operation. The following case is interesting in many respects:

A male, 37 years old, with a good family history, had never been ill. Up to within six weeks of the time the patient was first seen there apparently had not been any renal symptoms. The

patient, however, became suddenly ill with pain in both renal regions accompanied by anorexia and abdominal distension. Since the commencement of the illness the urine appears to have shown a considerable deposit and, at the same time, the amount was markedly decreased.

After judicious medical treatment had been resorted to for several weeks, the urine continued to be passed in very small amounts, was decidedly cloudy and contained a fairly large amount of albumen. A few days before coming under observation the amount of urine excreted became less and less until complete anuria resulted. Up to this time the patient's general condition was fairly good and he did not suffer, but, in order to prevent the appearance of uremic symptoms, he was placed under surgical observation.

When first seen the anuria had been present for a day and a-half. Physical examination showed a large, well-built man, with slight œdema of the feet. The mental condition is not changed other than for some slight confusion. The pulse was weak and about 70 to the minute. The thoracic organs appeared normal and no intestinal symptoms were present. Palpation of the renal region elicited no more pain on the right than on the left, but he stated that the last attacks of pain had occurred on the left. Neither kidney could be palpated.

An operation was undertaken at once and since the patient complained of more pain on pressure over the left kidney, and as the kidney could be palpated on that side, as well as the objective diagnosis, this gland was presumed to be the one that had retained its functions up to the last. As to the condition of the right kidney, and whether or not it had become physiologically without value, was a problem that could not be solved. Likewise the etiology of the anuria could not be made out with any certainty, although a reflex calculous anuria, or obstruction of the ureters with calculi, was considered probable. The left kidney was consequently exposed and was found tumefied and hyperemic, but otherwise apparently normal. The renal pelvis was of normal size and the ureter, as far as it could be palpated, was normal. The kidney was then split open and a small amount of cloudy urine made its exit from the renal pelvis. Retrograde catheterization of the ureter revealed nothing, as the instrument could be

pushed into the bladder. The operation was completed by gauze plugging and a drainage-tube. The outcome was satisfactory, because, several hours after the operation, large amounts of urine came from the wound, but none from the bladder. This continued for ten days and then less urine was excreted through the tube, while the quantity expelled by the bladder increased. During convalescence the patient experienced attacks of pain in the right kidney and with each of these there was a decrease in the amount of urine passed. After eight days, the attacks of pain on the right ceased and did not return and, as the wound was closed and the patient felt perfectly well, he was discharged twenty-five days after the operation. We heard from him three months later, when he stated that he was in the best of health and the amount of urine passed was normal. Seven months after the operation he again complained of pain in the right renal region, but the amount of urine did not decrease, though it was found to contain a considerable amount of albumen. Upon examination the right renal region appeared tumefied, and upon incision a large amount of pus was let out, which surrounded the kidney, but the wound closed kindly in a short time.

From this it would appear that a calculus or calculi were present in the right kidney, and that a pyelonephritis had developed and resulted in a pararenal abscess by which the concretion had made its exit. A year later the patient was in excellent health.

A very similar case has been recorded by Mittag, which occurred in von Bramann's clinic, and another by Godlee. The latter case is briefly as follows:

A physician, 31 years of age, suffered from septicemia when a student in 1872, as a result of an injury; otherwise he had been well until the last two years, when he had occasional attacks of right-sided renal colic which were relieved by morphine. The attacks became more severe and associated with anuria, while the urine showed quite an amount of albumen and many hyalin casts. In July, 1885, a deep-seated perinephritic abscess was opened, but the kidney could not be discovered. No urine came from the wound, and the albumen considerably decreased. In December of the same year complete suppression

of urine again occurred, lasting a week. No operation was undertaken, because it was supposed that there was only one functioning kidney, whose ureter had been occluded by a calculus. Death took place a week later. Autopsy showed a large pus-pocket in the right kidney with a calculus lodged in the middle of the ureter, above which the tube had become greatly dilated. The left kidney was large and normal, and microscopically only showed evidences of a mild interstitial nephritis. The interesting points in this case are that an abscess in the right kidney could produce such a considerable amount of albumen and casts in the urine and that the irritation in the right renal gland could cause complete anuria, although the other organ was comparatively healthy. Godlee expressed the opinion, in reporting the case, that perhaps the amount of morphine given the patient had some bearing in the production of the anuria.

In a case occurring at the surgical clinic at Halle, a renal abscess on the right side was present, which at times gave rise to considerable albumen in the urine. Here again the irritative process arose in the diseased right kidney, producing anuria from its reflex effect on the secretion in the latter.

We now come to reflex anuria arising in traumatism of one kidney, and we will first consider direct traumatism. In traumatisms of the kidney, whether they be operative or not, anuria may arise, although the opposite gland may be normal. Marsh and Clark have met with such instances, although, under the circumstances, one is dealing with a combined action of various factors, which, according to the above-mentioned authorities results in a too complicated process to allow one to consider the condition as a reflex anuria with any certainty. On the other hand, other observers have reported cases which are more important. Butler has published the following case:

A laborer 43 years old received a blow on the left side of the abdomen, and, although the region pained him, he continued to work for four days. On the fourth day following the accident anuria suddenly occurred, accompanied by rigors, nausea and violent pain in the back. When seen on the tenth day after anuria had set in, his breath possessed a distinctly urinous odor and the abdomen was slightly distended. On the next day there was vomiting and muscular twitching during sleep, and two days later he died with all the symptoms of uremia. Autopsy showed a cystic atrophic kidney with a patent ureter.

The left kidney was considerably enlarged and bound down by old and new adhesions. The ureter was distended with urine and at its middle was found a complete obliteration; in the radicles of the renal vein, thrombi were found, which at first sight looked like small calculi.

After removal of one kidney anuria may follow, and if the condition is not overcome death soon results from uremia. Anuria arises under these conditions, either from the fact that the opposite kidney was diseased to such an extent that its functions had been carried out altogether by the organ removed, or, on the other hand, the heart may have been undergoing a pathologic transformation for some time and its action becomes weakened from the narcosis and loss of blood which accompany all operative interferences. In the latter case, from the poor blood supply ischemia of the kidney results, causing rapid degeneration of the renal epithelium and, with this, cessation of its functions. Without any doubt disturbances in the kidney occur, which, in some cases, are rapidly overcome, while in others an acute inflammatory process arises, resulting in a diminution of the secretion, which finally ceases. Autopsies on these cases show either an extreme cloudy or fatty degeneration with necrobiosis of the renal epithelium, or the kidney may present an interstitial infiltration in which the renal epithelium also tends to become considerably involved. In the milder cases a reflex action in the healthy kidney is the result of the anuria, but in other instances other influences, probably of a purely nervous nature, are to be taken into consideration, which are evidently direct irritations far exceeding the physiological point. It is not possible for a perfectly healthy kidney to fail under the burden suddenly imposed upon it by the removal of its fellow, so that one should search for some other influences of specific irritation. Bonardi has shown experimentally that in animals from whom a kidney has been removed under narcosis, the subjects were more susceptible to infections and intoxications. A very serious influence upon the renal epithelium resulting from the narcotic used, whether in the form of a direct irritation, or ischaemia resulting from

the narcosis, is most doubtful. One should always take into consideration the absorption of chloroform into the system which, in itself is not dangerous, but combined with other influences is apt to increase the danger.

Certain antiseptic materials when coming into direct contact with a wounded surface in large quantities, are far more important than either ether or chloroform. The deleterious action on the kidney of carbolic acid, iodoform, and especially bichloride of mercury, is well known, and if into the bargain the heart's action becomes weak, a condition not infrequently observed in doing nephrectomy, the danger then increases to a considerable degree. For this reason I am of the opinion that in the removal of a kidney the aseptic technique is the one to be preferred.

In this respect an interesting case of anuria following removal of the kidney, occurring in the surgical clinic of Marburg, has been reported by Barth. The case was a malignant tumor of the right kidney in a five-year-old child. The decreased amount of urine existing before the operation did not at first undergo any considerable change after the kidney had been removed, and the amount excreted even began to increase. The patient convalesced and appeared out of danger, when, on the fourteenth day, he was nauseated and sleepy, while the amount of urine rapidly diminished, only 40 grams being passed on the next day, which contained albumen and large numbers of red blood-cells. On the day following complete anuria set in, with marked uræmic symptoms. The pulse was irregular and intermittent. On the following day the condition suddenly changed; the urine was secreted to an amount not reached before, the pulse became regular, and all the alarming symptoms disappeared, and from this time on the patient rapidly recovered. The remaining kidney was not enlarged, nor painful, the chemical and microscopic changes in the urine were only present during the attack, and examination of the bladder showed it to be perfectly normal.

To sum up, it may be said that this was a reflex anuria, probably arising from irritation of the nerves in the stump of the removed right kidney and this caused a reflex angiospasm in the vessels of the left organ, resulting in the cessation of the secretion. The irritation producing a reflex was probably due to an inflammatory swelling of the granulating wound in which

the nerves were imbedded. The change in the heart's action should also be taken into consideration in this case. The pulse was very irregular and markedly intermittent during the attack, a condition of affairs not observed either before or after the attack. This phenomenon may, however, be explained when one takes into consideration the intimate and direct relationship existing between the vagus and the vasoconstrictors of the kidneys, as has been demonstrated by Masius.

Israel has recorded several cases of anuria following extirpation of the kidney, but he says that although complete anuria occurred, it was not the result of reflex influences, but wholly dependent on the weakened condition of the heart. This authority is skeptical regarding reflex anuria, although he does not consider it impossible and, according to his way of thinking, so many conditions are present during an operation that it would be difficult to consider the anuria following as due to any one particular cause. In his own cases the patients presented atrophic or parenchymatous changes in the myocardium and from the narcosis, the operative traumatism, and so forth, the heart, already in a diseased condition, was influenced in such a way that the renal activity would become lowered as the result of diminished blood-pressure. In point of fact, the latter is certainly of great importance, whether resulting from a weak heart or a reflex vasoconstricting action on the renal vessels. From the development of ischemia, if it persists for any length of time, severe damage to the renal epithelium results, but it can recover if the blood-supply is not interfered with for too long a time. An increase in the secretion of urine then follows, and the fact is clinically of great interest, because, to a certain extent, it represents a physiological reaction of the renal blood-supply, or rather, perhaps, its nervous apparatus, upon the preëxisting condition of irritation. An angioparesis of short duration follows angiospasm and, as in animal experiments, results in an abnormal secretion of urine. Clinically, this phenomenon is a very well-known occurrence.

The following case is not devoid of interest. A male, 41 years of age, was seen in the middle of January, 1900, complaining of a fulness in the bladder even when the organ was empty. Five days later a swelling was found just below the region of the stomach, with borders which could not be distinctly defined. Considerable pain was elicited in the tumor upon pressure. The patient complained of pains in the legs and back. The descending colon was found lying over the tumor, which extended from the left renal region down into the pelvis. Inflation of the stomach caused the resistance to disappear. The surface of the tumor appeared smooth. The growth increased in size very rapidly, so that by the first of February the patient was extremely weak and œdema of the lower extremities appeared. At no time were either albumen or casts found in the urine, but, on February 10, a trace was discovered and the specific gravity 1.004. The daily amount had averaged about 1300 grams, when suddenly on February 11 the urine decreased, only about 650 c.c. was voided, and the next day a little less. On February 14 complete anuria arose. When seen in consultation on this date, the patient was found extremely emaciated, with considerable œdema of the lower limbs. The tumor presented in the left hypochondriac region in the form of a hard swelling with a smooth surface and not adherent to the abdominal wall. The growth reached nearly to the median line, and its lower borders appeared to be about two fingers' breadth below the umbilicus. It was not movable. The growth in the abdomen might be roughly estimated as the size of an adult head. No fluctuation could be elicited. No functional disturbances of the stomach or intestine. By inflation of the large intestine the descending colon appeared to be displaced towards the middle line and somewhat downwards. The thoracic organs showed no evidence of disease.

Hydronephrosis was eliminated on account of the absence of fluctuation, but, although there was little or no rise in temperature, I did not feel that renal tuberculosis could be eliminated, although I was under the impression that I was more likely dealing with a sarcoma of the left kidney. But it might be either of the two latter diseases which had resulted in anuria, produced by pressure of the ureter from metastases in the mesenteric lymph-nodes on the right with displacement of the left ureter from direct

pressure, or, on the other hand, the anuria might be due to retention from compression of the right ureter from growths developing in the small pelvis. The marked œdema could be best explained from congestion due to compression on the inferior vena cava.

For the next few days that the patient was under observation there was complete anuria, proven by catheterization. The œdema increased, the patient complained of headache, and was constantly nauseated. The pulse ran high and, on account of the threatening uræmia, it was decided to operate. The right kidney was selected as the organ to be operated on, because it was practically certain that it was the healthy organ. Consequently the kidney was exposed by a lumbar incision and split open. The renal pelvis was found somewhat enlarged. The opening in the kidney was packed with gauze. For the next few days large quantities of urine were passed by the drain, it being somewhat cloudy and containing some epithelium presenting characteristics of fatty degeneration. A little urine was also voided from the bladder. The amount of urine coming from the wound and from the bladder varied and when a small amount was passed by the tubes the amount in twenty-four hours practically was equalled by the amount passed from the bladder. After the operation the patient's condition varied; at times his mind was clear, the appetite good and the tongue moist, while at others he was confused, vomited, and was persuaded with difficulty to take nourishment. He finally sank, and died nine days afterwards. Unfortunately no autopsy could be obtained.

Although more proof is not necessary to show that a renorenal reflex can result in the cessation of function of the kidney on the opposite side, I nevertheless would briefly allude to one case recorded by Israel, that of a young woman who, after removal of a right-sided hydronephritic kidney, presented reflex anuria due to irritation of the drainage-tube on the opposite side, which was too long. That this was so, is proven from the fact that immediately after the drainage-tube was shortened the amount of urine immediately increased to 3,000 cm. and, after this polyuria had lasted for several days, the urinary secretion returned to the normal.

In anuria due to cholera one finds, according to Rosenstein, a marked venous hyperæmia of the kidney, the organ being occasionally enlarged. Microscopically, casting off and degeneration of the epithelium is noted, although there appears to be an anatomical integrity of the secretory apparatus. The glomeruli of Malpighi, tubules and capsule, as well as the interstitial tissue, appear to be intact. Since the amount of urine voided depends, according to Ludwig and Heidenhain, upon the blood-pressure, and the rapidity of the flow in the glomeruli, the anuria occurring in the asphyxic stage of cholera is to be explained from this fact, because, in this stage of the disease, the pulse can hardly be felt, and consequently the circulation practically entirely ceases.

In the commencement of diffuse nephritis there is usually oliguria, so that the amount of urine in most cases will hardly exceed one hundred c.cm. In severe cases anuria may develop and last for one or several days. At the commencement of convalescence the 24-hour amount of urine appears increased and polyuria is not infrequently present. The anuria and oliguria appear to find an explanation through the almost complete blocking up of the urinary canals with casts. Whitelaw describes a case of anuria in a boy eight years old which lasted 25 days, commencing two months after the development of a scarlatina. Exceptional cases, however, occur where the connection between a diffuse nephritis and anuria is not at all clear, in which the suppression of urine suddenly occurs without any previous symptoms of any inflammatory process, and it is only operation or autopsy that reveals the correct condition of affairs. Such a case has been recorded by Israel, where a diffuse nephritis of both glands resulted in complete arrest in secretion of urine. As the anuria arose suddenly without any premonitory symptoms and without any qualitative or quantitative change in the urine, it was impossible to make a diagnosis beforehand.

It is well known that in cases of diffuse nephritis, especially when following scarlet fever, oliguria occurs, but

absolute anuria is uncommon. However, anuria is far more infrequent in ascending pyelonephritis than in hematogenous nephritis, for the simple reason that in the former the renal changes are not diffusely spread and exist rather more in the form of foci. Israel, however, has met with complete anuria in a case of left-sided sub-acute ascending pyelonephritis in a patient whose right kidney had been removed eight months previously on account of tuberculosis of the organ. The arrest of secretion is probably to be considered as a result of the acute inflammatory process with increased intrarenal pressure and from this results a sudden increase in tension, which explains the initial attacks of pain which may readily lead the clinician to make a diagnosis of occlusion from calculus. By slitting open the kidney the excessive pressure on the parenchyma can be relieved, because the blood, tissue-fluids and inflammatory products can be eliminated, and circulation is restored throughout the organ.

I now come to consider the most frequent cause of anuria, namely, renal calculus. Complete suppression of urine can more readily be understood in those cases where occlusion of both ureters occurs at the same time, or where only one functioning kidney is present. I have already mentioned how a failure in the functions of the second kidney, although perfectly capable of functioning, may arise when the ureter on the other side is obstructed, this being the result of a reflex vasoconstrictor type. Nephrolithiasis is more apt to make itself known after the thirtieth year of life, and generally only gravel and small calculi are voided. However, as these patients advance in years, the calculi from the kidney become larger in size, so that they cannot be expelled by the ureter. Now, if a patient presenting anuria has suffered for a number of years with renal symptoms, and if the passage of the stones has been painful, one should be on the lookout for hydronephrosis. During anuria calculosa, a hydronephrosis would hardly be formed, because the occlusion takes place suddenly, but only for a short time will the kidney secrete a small amount of urine.

Cohnheim was, I believe, the first to experimentally develop hydronephrosis, and he came to the conclusion that in complete obstruction of the ureter hydronephrosis can only occur to a mild degree, because the enormous tension set up rapidly produces a failure in the secretory power of the organ, and that very large hydronephrosis arises only in incomplete obstruction of the ureter. Clinically speaking, three possibilities may exist as far as the development of calculous anuria is concerned: either both kidneys with perfect functional integrity are arrested in their secretion from a calculus becoming lodged in the ureter, the same thing occurring in the other very shortly afterwards, or what is more uncommon, at the same time; secondly, we may have one kidney which is physiologically worthless on account of previous lesions and the only one that is carrying out the work becomes clogged by occlusion of its ureter; and lastly, we have those cases where the patient has only one kidney, the other having been removed for some lesion, or is congenitally absent.

Considering the case of two kidneys in perfect functional order, whose ureters have both become obstructed by a calculus, I am only aware of one recorded case, due to Haebner. That occlusion of both ureters must have occurred at about the same time, or within a very short interval, was shown from the fact that the mucosa at the points where the calculi were wedged in presented ecchymosis and the commencement of an ulcerative process, while the parenchyma of both kidneys gave evidences of the same condition. It is quite true that there are a number of instances of calculous obstruction in both ureters, in all of them one kidney was always functionally worthless on account of some former lesion. In these cases reflex anuria does not exist, but they were frequently classified under this heading, on account of superficial observation of the case. Bischoff has published a case of anuria which lasted 23 days, where both ureters were occluded by calculi, but the right kidney had not been functionally active for a number of years. Several instances of calculous anuria have been recorded by Israel, but they differ in no way from the others.

One is always dealing with the mechanical form of anuria, one where one kidney has been diseased for some time and occlusion of the functioning organ naturally leads to suppression of urine. Thus in Arlowski's case, which resulted in death from anuria of 18 days' duration, both glands had become physiologically worthless on account of the calculi; while in Ultzmann's case, in which anuria of 14 days' duration terminated fatally, the right kidney was found obliterated, while the left was double the normal size and a stone was found lodged in the ureter. The literature of all countries is replete with such cases. The following case is especially interesting for the reason that the function of the left kidney was suddenly overcome by occlusion of its ureter with a calculus, while the right kidney had apparently lost its functional powers some time past; these were regained, however, just at the time when an operation was about to be undertaken for the relief of the condition. The patient had frequently had attacks of pain on the right, followed by the passage of calculi, so that it could be reasonably supposed that the right kidney was already diseased. Then renal colic occurred on the left side. Anuria appeared, which lasted for nine days, so that it was decided to operate, but while being prepared for the operation, the patient suddenly began to pass urine and two days later a calculus, the size of a pea, was voided.

The third possibility for the occurrence of calculus anuria, aside from reflex anuria, is where only one kidney exists. It is true that, so far as I am aware, only two instances of anuria arising after the removal of one kidney have been encountered. The first case occurred in the practice of Dr. Lewis S. Pilcher, to whose courtesy I am greatly indebted for the privilege of reporting this case, which has not as yet been published, while the second, met with by Dr. F. Kammerer, is recorded in this issue of the *ANNALS OF SURGERY* (page 113).

A male, 32 years of age, was admitted to the Methodist Episcopal Hospital in Brooklyn, N. Y., on October 8, 1905, with a history that in December, 1902, after an uncertain period of

previous symptoms, he had been subjected to a nephrolithotomy of the left kidney by Dr. A. T. Bristow at the King's County Hospital. A fistula persisted after this operation, in consequence of which he was again admitted to the same hospital in July, 1904, in the service of Dr. William Maddren, by whom a complete extirpation of the left kidney was done. From this operation he made a good recovery, with complete healing of the operative wound. He remained well thereafter until September 1, 1905, when he began to complain of pain in the region of the remaining right kidney. This had persisted with remissions and exacerbations for five weeks, during which time he was under medical treatment, but without relief.

On the evening of October 8 the pain suddenly became very severe, and was attended with vomiting and a rise in temperature. On account of this attack he was brought to the Methodist Episcopal Hospital for treatment, with the statement that no urine had been passed since the attack began. Examination revealed rigidity of the abdominal muscles in the right hypochondriac region; tenderness on pressure in the right lumbar region, where an enlarged right kidney was palpable. Temperature 101.6° ; pulse 120; respiration 40. Blood examination: white blood-corpuscles 19,400, polynuclear leucocytes 87 per cent. Nine hours after admission, having passed no urine during this time, he was catheterized and less than a half teaspoonful of urine was obtained from the bladder. Twelve hours after admission the right kidney was exposed by a lumbar incision. It was found swollen, congested and œdematous. The renal pelvis was much distended, and when incised several ounces of urine gushed from the opening under great tension. Some pus was mingled with the urine. Through the opening in the renal pelvis twenty-three calculi, varying in size from that of a split pea to a hickory-nut, were then removed and the interior of the cavities in the kidney was thoroughly irrigated. A sound was passed down into the ureter, which was found patent. The outlet from the pelvis of the kidney had evidently been blocked by one of the calculi which had been removed. A rubber drain-tube was inserted down into the renal pelvis and the incision in the latter was closed by chromic gut down to the tube. The greater portion of the operative incision was closed by sutures, a moderate tampon of iodoform

gauze being placed around the tube from skin to kidney. For the first twenty-four hours after the operation the discharges from the wound were very slightly urinous in odor and no urine passed down into the bladder, as ascertained by the passage of the catheter. Nitroglycerin and an abundant ingestion of fluids were then prescribed. During the second twenty-four hours, 105 ounces of urine were voided from the bladder. From this time the function of the kidney and bladder continued normal. The drainage-tube gave issue to a light amount of urine during the first ten days. On the fourteenth day the drainage-tube was discontinued, after which the sinus rapidly closed. The patient made an uneventful convalescence and was discharged cured at the end of five weeks from his admission.

A case of anuria has been reported by Meyer which occurred thirty-eight days after nephrectomy and was due to obstruction of the ureter by clots and pus. Nephrotomy was performed successfully. During life it is hardly possible to make a diagnosis of the presence of only one kidney, and it is usually at autopsy that this is discovered. In this respect I would mention Schwenger's case. The patient had always been well up to the time of an anuria which lasted nine days. This was ushered in with severe pain on the right side and death resulted. Autopsy revealed the absence of the left kidney, not even a rudimentary organ being found. Occlusion by a calculus lodged in the ureter was the cause of the anuria.

The diagnosis of calculous anuria can ordinarily be made from the history of the case, because these patients generally have been previously troubled by urinary symptoms, such as the passage of gravel or a calculus. Colicky pains and blood in the urine precede in many cases the passage of a stone, but, on the other hand, every symptom may be lacking, the anuria suddenly occurring without any warning. Now, since anuria is not an infrequent symptom of nephrolithiasis, this condition should be first considered, but some difficulty may be encountered in those cases where the patient gives no distinct history of past trouble. However, the first thing that comes

to one's mind is whether or not a calculous obstruction exists in both ureters, or only in one, and, if the latter, upon which side ? Then, if it is ascertained that both ureters are obstructed, it is most important to determine which kidney was the last affected, because when the functioning kidney becomes the object of operation, the outlook is good if the obstruction can be removed, as the other kidney may have been physiologically worthless for some time. In order to come to a correct conclusion the history given by the patient himself will greatly help, because he will probably be able to give information as to the side he first felt the pain in. When the answers relative to pain are definite, one should always bear in mind the possibility that the last pains felt may have been in the diseased kidney, due to a renorenal reflex, and this has been shown in a case reported by Israel. The objective findings are hardly worth considering, for even if by purely objective diagnosis the other kidney is found diseased, it still remains questionable whether it is the cause of the anuria and perhaps functionally worthless for a considerable length of time, and whether or not if the remaining functioning kidney were attacked by operation it would relieve the anuria. The pain resulting from pressure on the obstructed side is not of much value, but Israel considers as a valuable symptom a marked rigidity of the abdominal walls on palpation, which occurs on the side where the kidney was last occluded. As to the value of catheterization of the ureters, opinions vary. As this can only be done with a very fine and rather soft bougie, there is a question whether or not the instrument would allow one to recognize the presence of a calculus when it came in contact with it, because the instrument may become caught in a fold of the mucous membrane of the ureter which is swollen and inflamed, or it may be grasped by a spasm of the ureter. However, if a stone should be diagnosticated, the kidney may have been destroyed for some time and the obstruction may have been present for many years, while the remaining kidney has only become physiologically involved recently. Now, supposing a

stone should be detected in the ureter of the latter, it is questionable whether the obstructing calculus is not located in the ostium of the renal pelvis. The passage would consequently then be free and the only infallible sign is when no urine is seen by the cystoscope making its exit from the ureteral orifice. Of equally little value is radioscopy, because the stone is not always made evident. Consequently one may say that the kidney to be operated on is the one which was the seat of the last pain, or when this cannot be ascertained with certainty, then one should operate on the gland which, on palpation, gives rise to the greatest pain, or on the side where the greatest reflex rigidity of the abdominal walls is found.

As to the time when the operation should be undertaken, it at once becomes evident in looking over the reported cases that the result of the operation depends entirely upon this factor. Israel advises not waiting longer than forty-eight hours if the obstruction is not removed after this time, and statistics plead in favor of a timely interference. Leguen showed, in 1891, that the number of cures of calculous anuria where operation was undertaken amount to 66.6 per cent., while in those left alone only 28.5 per cent. recovered. Other French authorities opine for early interference.

When Tuffier introduced nephrotomy, in 1890, surgeons began to attack all renal calculi and those situated in the upper part of the ureter by splitting open the kidney, and personally I feel prepared to say that when the obstacle in the ureter cannot be removed, the kidney should always be opened in order to give exit to the urine.

Relative to those cases of anuria whose cause is due to ureteral obstruction from blood-clot or compression from without, it may be said that they are rare, and it is probable under these circumstances that the other kidney is functionally destroyed. Some years ago I treated the question of anuria resulting from extension of carcinoma of the uterus in a paper published in the *Boston Medical and Surgical Journal*, so I will not refer to it here. Anuria is certainly very rare as the

result of compression of the ureter, but Farlow reported a case in the above-mentioned journal in 1889, where death occurred in twelve days. The patient was a woman thirty-five years of age and autopsy revealed a firm, fibrous mass inclosing the walls of the ureter. The ureters and renal pelves were considerably dilated. Patel remarks, in considering anuria resulting from compression of the ureters by abdominal tumors, that both ureters are really obstructed at the same time. Now, if anuria occurs it must be that both kidneys are diseased or that the kidney whose ureter is free has been deprived of its physiological functions by reflex action. He regards the explanation given in those cases which have been reported as unsatisfactory and believes that only the first theory is correct, basing his assertion on a thoroughly-observed case occurring in Poncet's clinic.

In closing this paper I cannot refrain from recording one case of anuria of puerperal origin, and where I feel quite certain that had I done a nephrotomy the patient might possibly have been saved. As it was, bilateral decapsulation was done and although some improvement manifested itself, the patient died four days after the operation. The history of the case is briefly as follows:

A young woman, 26 years of age, was delivered on a Saturday evening, the labor requiring only the application of the low forceps. Everything was perfectly normal until at noon on the Thursday following the patient was taken with a rigor and the temperature immediately rose to about 39.5° C., the pulse following it proportionately. The attending physician rightly suspecting that some uterine infection was showing itself, immediately resorted to intra-uterine irrigations. On the same evening the patient, who had voided no urine during the day, was catheterized and the bladder found empty.

After the irrigation the temperature did not go up and the pulse returned to nearly normal, but from this time on complete anuria existed. I saw the patient in consultation on Sunday morning,—i. e., after the anuria had been present for about 60

hours, and made the following notes: Mind perfectly clear; pupils normal; tongue moist but furred. Pulse 80, temperature normal. Bimanual examination revealed nothing abnormal in the genital apparatus. There was no œdema other than a slight puffiness under the eyes.

The patient was immediately removed to a private hospital, where a radical treatment to combat the suppression of urine was immediately undertaken, consisting of hot packs, pilocarpin subcutaneously, and acetate of potash internally, with a milk diet. This treatment was carried out for 48 hours without attaining any result, and not a drop of urine could at any time be obtained from the bladder. On the next day the œdema of the face became more marked, and also appeared at the ankles, while the pulse increased in rapidity and was of a wiry nature. On Tuesday morning,—that is to say, five days and a-half since the commencement of the anuria, the condition was the same, but the œdema had become more marked so that operation was immediately decided upon. Narcosis with ethyl chloride and ether. Bilateral decapsulation was done at one sitting, my assistant, Dr. Rolfe, doing one kidney, while I did the other. The glands were exposed by transverse incision, and were found greatly enlarged, tense and extremely hyperæmic. Decortication was rapidly accomplished, as the kidney popped from its capsule like a pea from a pod. Capsules were resected, the kidneys dropped back and the wounds sutured. Duration of the operation thirteen minutes.

During the next twenty-four hours the patient voided 270 c.c. of very albuminous urine containing casts; in the next twenty-four hours 300 c.c. were voided, but during the next twenty-four suppression again became complete, the œdema markedly increased, the mouth became dry, and the patient was delirious. She died sixteen hours later.

The autopsy revealed absolutely nothing abnormal in the abdominal viscera and microscopical examination of the kidneys showed that we were dealing with an acute parenchymatous nephritis, as had been diagnosed clinically.